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April 15, 2008

**Mr. Shahid R. Merchant**  
**Art Unit: 3694**  
**United States Patent and Trademark Office**  
**Attn: Commissioner for Patents**  
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Dear Mr. Merchant,

I am writing to respond to the Office Action Summary for Patent Application No. 10/729,654. Reference is made to three other patents and one publication in rejecting the primary claims of the application. I believe that the discussion below will clear up some semantic issues raised in your report and also show that the invention under consideration is not implied by the cited works separately or collectively.

I should also mention that the attorney and legal firm (Fitch, Even, Tabin & Flannery) that filed the original application are no longer involved in this filing. I have signed and returned the revocation of power of attorney and am informed by the firm that it has been submitted to USPTO.

First of all, I believe that the attorney involved in the initial patent application should not have used the term "substantially" in conjunction with "risk-neutral valuation" and "arbitrage-free valuation". Both terms do, however, constitute standard derivatives terminology found and explained in any standard option pricing book (for example, see pages 275-277 of "Introduction to Options and Futures" by John Hull, 8<sup>th</sup> edition). These terms have a very clear and concise meaning to those with ordinary skill in the art of option pricing. It is, therefore, important to note that three of the four references cited in the Office Action Summary as collectively implying the invention (Rudkin (2004), Ayache (2002) and Asca & Neube (1998)) use an alternative *utility-based* framework to valuing stock options. *Utility-based* option pricing methodology is very different in theory and concept from the *risk-neutral valuation* framework extended in this invention to value stock options with multiple termination risks. For example, the utility approach requires specification of the employee's utility function, risk-aversion parameter and

level of wealth. None of these are used as inputs in risk-neutral option pricing. Also, the utility approach uses certainty-equivalent arguments to define the option value while the risk-neutral framework is based on no-arbitrage arguments.

Moreover, the references cited in the Action Summary deal with different topics in financial engineering and do not in the aggregate lead to or imply the results described in the patent application. First, as discussed below in greater detail, Schultz (2004) describes a generic architect for a stock option management and optimal exercise system which uses the standard Black-Scholes model or some un-described "hybrid" version of it. Second, the methodology of Rudkin (2002) uses a *utility-based* approach to find the option value to the employee while Pandher (2002) extends the *risk-neutral* approach to capture multiple terminations risks in the valuation of stock options (unlike Rudkin (2002), the employee's wealth, utility function and risk-aversion parameter are immaterial to this methodology). Next, Ayache (2002) extends the lattice representation to price options on multiple assets and has no clear relation to Pandher (2002) which extends the binomial model to capture multiple termination risks on the stock option value (the only similarity is that both use a lattice structure to represent the asset price dynamics). Lastly, the reference to Asea & Ncabe (1998) is largely irrelevant because the paper uses a *utility-based* framework with jumps in the asset price dynamics. As mentioned earlier, the methodology of Pandher (2002) falls in the *risk-neutral* framework that does not require utility functions and, secondly, there are no jumps in the stock price dynamics; instead, jumps occur to the stock option value and these depend on the type of employment termination event (e.g. voluntary termination, dismissal, mortality event). It is impossible to model this feature of employee stock options using jumps in the stock price.

A more detailed discussion of differences in the methods of Pandher (2002) from the four cited works in the Action Summary report is give below.

#### **Schultz (2004)**

Schultz (2004) is largely a "communications network" for employee stocks option that provides a general system for managing stock options granted to employees with some ability to identify optimal option *exercise* scenarios. The management system uses the standard Black-Scholes in forecasting these scenario (Schultz, paragraph 69). The document does not describe how the method uses information on employment termination (e.g. death, disability) in identifying the best option exercise strategy, aside from making a loose reference to a "hybrid Black-Scholes" model. Therefore, it is difficult to see how the methods of Pandher (2002) fall under this prior disclosed art as asserted in claims 8)-22) in the Action Summary. In fact, the invention in Pandher (2002) does not use the Black-Scholes model or any variant of it. The proposed valuation of stock options is implemented by i) an extended binomial model that models the effect of multiple termination risks on the option or ii) solving a multi-severance risk partial differential equation derived in the invention. Schultz (2004) makes no mention of using either of these methods in valuing stock options.

**Rudkin (2004)**

The methodology of Rudkin finds the stock option value by maximizing the utility of the wealth of the employee holding the stock option. To anyone with ordinary skill in the art, it is obvious that risk-neutral valuation methods do not require the employee's utility function, risk-aversion parameters, knowledge of the employee's wealth and certainty equivalent arguments (see Rudkin 52-58, 73). Also, Rudkin's valuation method finds the value of the option to the employee (the option holder) – not the employer. On the contrary, the risk-neutral valuation of Pandher (2002) finds the value of the stock option to the company – as opposed to the employee – and the valuation method is not based on certainty equivalent arguments (it uses “no-arbitrage valuation” arguments). Hence, the methods of Pandher (2002) do not even use the same data and information as Rudkin (e.g. employee's wealth, risk-tolerance parameter) as inputs (see Rudkin, 55-56). Therefore, to someone of ordinary skill in the art, it is difficult to see how Rudkin's methods lead to the valuation methodology of Pandher (2002).

**Ayache (2002)**

The author clearly states that the invention proposes “A method for pricing the current value of a basket option consisting of a *plurality* of underlying *assets*” (Claim 1). The implementation uses a lattice representation for the assets' price evolution. The valuation in Pandher (2002) is in the standard one-asset setting but extends the binomial model to allow for multiple termination events that can lead to termination of the option. It is impossible to see how Ayache's methods for implementing a multi-assets lattice (with not even *one* termination risk) leads to the multi-termination risk extension of the binomial model proposed in Pandher (2002).

**Asea & Ncube (1998)**

This paper also develops a utility-based option pricing model (see equations 4), 5), 22) and 23)) where information of jumps in the asset dynamics follows a doubly stochastic Poisson process. The partial differential obtained involves market prices of risk based on the indirect utility functions (terms involving “J”). Again, this is a different theoretical framework than the risk-neutral valuation approach of Pandher (2002) which does not require specification of the option holder's utility function, risk-aversion parameter and wealth (see 4) and 5)). Furthermore, the asset dynamics in the two papers differs in a very important respect. In Asea & Ncube (1998), jumps occur to the stock price dynamics while in Pandher (2002), jumps occur to the option value and this depends on the type of employment termination event. Therefore, the utility and jump-based partial differential equation of Asea & Ncube (1998) is very different from the multi-severance risk partial differential equation of Pandher (2002) and the former does not lead to or imply the latter to anyone of ordinary skill in the art.

**Conclusion**

The above discussion of the four references cited in the Examiner's report shows that the patent application describes a new and novel method for valuing employee stock options that cannot be inferred from, and is independent of, disclosed methods at the time of the invention by anyone with ordinary skill in the art. Three of the cited documents use an alternative *utility-based* approach to capturing feature of employee stock options. The

extension of the *risk-neutral option valuation* framework to multiple option termination risks in Pandher (2002) is based on an entirely different methodology that does not require the employee's utility function, risk-aversion parameter, the employee's overall wealth or certainty-equivalent arguments. Hence, the lattice representations and partial differential equation obtained in Pandher (2002) to value stock options under multiple risks are not comparable or even derivable from the results of Rudkin (2004), Ayache (2002) and Asca & Ncube (1998) by someone of ordinary skill in the art. The only similarity is that partial differential equations are involved (as in the fields of Physics and Engineering), but their form and the theoretical arguments behind them are completely different and independent. The fourth reference (Shultz (2004)), describes a stock option "communication network" that investigates optimal option exercise scenarios using the Black-Scholes model.

Lastly, a research paper describing the invention in this patent application was published in the highly regarded and peer-reviewed *Journal of Derivatives* in 2003. If the paper did not exhibit significant novelty and extension over existing option pricing methodology, it would not have been accepted for publication by the Editor, Associate Editor and Peer Reviewers.

In closing, I request you to reconsider the original decision regarding the primary claims of the patent application. It is unfortunate that the attorney appended the vague term "substantially" to well-defined terms "risk-neutral valuation" and "arbitrage-free valuation" in the art of option pricing. This appears to have created some semantic confusion in the reading of the application that lead to the earlier decision. If you need and further information, please do not hesitate to call me at 250-807-8128 or email [gurupdeshpandher@ubc.ca](mailto:gurupdeshpandher@ubc.ca). Thank you.

Sincerely,  
Gurupdeshpandher